PATENT COOPERATION TREATY

PCT

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

(PCT Article 36 and Rule 70)

Applicant's or agent's file reference MRH/PO16363WO	**FOR FURTHER ACTION**	See Notification of Transmittal of International Preliminary Examination Report (Form PCT/IPEA/416)
International application No. PCT/GB 02/05794	International filing date *(day/month/year)* 19.12.2002	Priority date *(day/month/year)* 19.12.2002
International Patent Classification (IPC) or both national classification and IPC C03B37/00		
Applicant GLASSFLAKE LIMITED et al.		

1. This international preliminary examination report has been prepared by this International Preliminary Examining Authority and is transmitted to the applicant according to Article 36.

2. This REPORT consists of a total of 5 sheets, including this cover sheet.

   ☒ This report is also accompanied by ANNEXES, i.e. sheets of the description, claims and/or drawings which have been amended and are the basis for this report and/or sheets containing rectifications made before this Authority (see Rule 70.16 and Section 607 of the Administrative Instructions under the PCT).

   These annexes consist of a total of 6 sheets.

3. This report contains indications relating to the following items:

   - I ☒ Basis of the opinion
   - II ☐ Priority
   - III ☐ Non-establishment of opinion with regard to novelty, inventive step and industrial applicability
   - IV ☐ Lack of unity of invention
   - V ☒ Reasoned statement under Rule 66.2(a)(ii) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement
   - VI ☐ Certain documents cited
   - VII ☐ Certain defects in the international application
   - VIII ☐ Certain observations on the international application

Date of submission of the demand	Date of completion of this report
29.12.2003	08.12.2004
Name and mailing address of the international preliminary examining authority: European Patent Office D-80298 Munich Tel. +49 89 2399 - 0 Tx: 523656 epmu d Fax: +49 89 2399 - 4465	Authorized Officer De Ruiter, F Telephone No. +49 89 2399-2921

INTERNATIONAL PRELIMINARY EXAMINATION REPORT

International application No. PCT/GB 02/05794

I. Basis of the report

1. With regard to the **elements** of the international application *(Replacement sheets which have been furnished to the receiving Office in response to an invitation under Article 14 are referred to in this report as "originally filed" and are not annexed to this report since they do not contain amendments (Rules 70.16 and 70.17))*:

Description, Pages

1, 4	as originally filed
2, 3, 5, 6	received on 28.11.2004 with letter of 28.11.2004

Claims, Numbers

1-6	received on 28.11.2004 with letter of 28.11.2004

Drawings, Sheets

1/1	as originally filed

2. With regard to the **language**, all the elements marked above were available or furnished to this Authority in the language in which the international application was filed, unless otherwise indicated under this item.

   These elements were available or furnished to this Authority in the following language: , which is:

   ☐ the language of a translation furnished for the purposes of the international search (under Rule 23.1(b)).

   ☐ the language of publication of the international application (under Rule 48.3(b)).

   ☐ the language of a translation furnished for the purposes of international preliminary examination (under Rule 55.2 and/or 55.3).

3. With regard to any **nucleotide and/or amino acid sequence** disclosed in the international application, the international preliminary examination was carried out on the basis of the sequence listing:

   ☐ contained in the international application in written form.

   ☐ filed together with the international application in computer readable form.

   ☐ furnished subsequently to this Authority in written form.

   ☐ furnished subsequently to this Authority in computer readable form.

   ☐ The statement that the subsequently furnished written sequence listing does not go beyond the disclosure in the international application as filed has been furnished.

   ☐ The statement that the information recorded in computer readable form is identical to the written sequence listing has been furnished.

4. The amendments have resulted in the cancellation of:

   ☐ the description, pages:

   ☐ the claims, Nos.:

   ☐ the drawings, sheets:

5. ☐ This report has been established as if (some of) the amendments had not been made, since they have been considered to go beyond the disclosure as filed (Rule 70.2(c)).

   (Any replacement sheet containing such amendments must be referred to under item 1 and annexed to this report.)

6. Additional observations, if necessary:

V. Reasoned statement under Article 35(2) with regard to novelty, inventive step or industrial applicability; citations and explanations supporting such statement

1. Statement

Novelty (N)	Yes:	Claims	1-6
	No:	Claims	
Inventive step (IS)	Yes:	Claims	
	No:	Claims	1-6
Industrial applicability (IA)	Yes:	Claims	1-6
	No:	Claims	

2. Citations and explanations

   see separate sheet

1. The apparatus of claim 1 differs from the apparatus disclosed in US-A-4 344 785 (D1) in that the means for effecting a change in the temperature of the stream while the stream is travelling in a vertically downward direction are means for directly heating the stream by application thereto of microwave radiation or electric current. Such direct heating by the application of microwave energy or electric current is, of course, well known to any person skilled in the art. As it is not clear which problem inherent to the apparatus known from D1 is solved by the above difference, or what advantages are achieved by this difference, the application of microwave energy or electric current to the stream does not appear to be more than technical alternatives that are obvious to a person skilled in the art, and thus does not appear to involve an inventive step.

   For similar reasons also the method of claim 5 does not appear to involve an inventive step.

2. The additional provision of cooling means specified in claim 2 is suggested by US-A-4 713 106, where such cooling means are provided for the same purpose as in the application (see column 2, lines 47 to 50 of D2; lines 1 to 9 of the description of the present application).

3. The additional features specified in claims 3 and 4 do not appear to be more than normal practice for a person skilled in the art. Moreover, the features defined in claim 4 are suggested by D2 (see point 4 above). Consequently, the subject-matter of these claims also does not appear to involve an inventive step.

4. For the reasons set out in point 3 above also the additional features specified in claim 7 do not appear to involve an inventive step.

5. It should be noted that the wording of claim 1 also covers the possibility that the stream of molten material travelling in a vertically downward direction is **not** free flowing, but flows through a vertical channel, like in the apparatus disclosed in D1, in which case the highest possible temperature the molten material can have in this vertical channel is limited by the construction and the material of the channel. A temperature of the vertically travelling stream of molten material higher than that achievable in the apparatus disclosed in D1 only appears to be possible with a free flowing vertically travelling stream of molten material.

   Hereby it also should be noted that the description and the drawing only provide

support for such a free flowing vertically travelling stream of molten material (see Article 6 PCT).

It finally should be noted that it does not appear to be possible to achieve a controlled heating of the stream of molten material travelling in the vertically downward direction by directly applying electric current to this stream when this stream is not free flowing.

the production of thin fibres or flake, particularly in the sub-micron range and changes in temperature as small as one degree cause variation in thickness. The viscosity of the glass mass within a source tank or reservoir is determined by temperature variations which in turn cause changes in mass flow through the outlet from which the stream emerges. Additional mass flow changes are caused by head variations within the tank.

Furthermore, in order to compensate for the heat loss outside the source tank, the temperature within the tank may need to be higher than the stream temperature by some hundreds of degrees. This is not only energy wasteful but may cause severe erosion and corrosion of the refractory lining within the tank.

Statements of the Invention

Apparatus for forming fibres or flakes of material comprising means for producing a heated stream of molten material, means for feeding the stream in a substantially vertically downward direction, means for receiving the downwardly directed stream and for forming fibres or flakes therefrom, and means for effecting a change in the temperature of the stream subsequent to the production thereof whereby fibres or flakes of a desired thickness are obtained, wherein said temperature changing means are means for directly heating the stream by application thereto of microwave radiation or electric current, while the stream is travelling in a vertically downward direction.

In accordance with the present invention the apparatus includes means for applying a high frequency (RF) current to the vertically downwardly travelling stream.

In another embodiment in accordance with the present invention, means are provided for applying an electric current to the vertically downwardly travelling stream.

In a further embodiment in accordance with the present invention, the apparatus may be additionally provided with means for cooling the stream prior to it being fed in a

downward direction. The cooling means may include a conduit through which the stream is fed, said conduit being surrounded by a cooling coil or jacket through which an appropriate cooling fluid, such as air, may be fed. The effect of cooling the stream within the conduit is to solidify an outer region of the stream in the vicinity of the outlet from the conduit. In this way, the volume mass flow of the flow stream is reduced.

Although this variation in the volume of the flow stream is produced by varying the temperature of at least the outer region of the flow stream, it should be appreciated that variation of the volume of the flow stream represents, in general, an additional method of controlling the thickness of the resultant flakes or fibres. Accordingly, the present invention provides apparatus as defined above in which in addition to the temperature changing means there are provided mass flow control means. Such control means are typically positioned to effect the mass flow prior to the stream being fed in a vertically downward direction.

The present invention further provides a method for forming fibres or flakes or material comprising producing a heated stream of molten material, feeding the stream in a substantially vertically downward direction, receiving the downwardly directed stream and forming fibres or flakes therefrom, and effecting a change in the temperature of the stream subsequent to the production thereof whereby fibres or flakes or a desired thickness are obtained, wherein the change in the temperature of the stream is affected by directly heating the stream by application thereto of microwave radiation or electric current while the stream is travelling in a vertically downward direction.

The present invention also provides a corresponding method in which the mass or volume flow of the stream is controlled, prior to the stream travelling in a vertically downward direction, in order again to produce fibres or flakes of a desired thickness.

Also shown in the drawing are components for another method of directly heating the glass stream. This method involves the passing of an electric current through the stream between an upward connection 19 in the form of an electrode connected to bushing 5. Such a connection can be achieved by using a bushing made of an electrically conductive material so that the bushing is itself the electrode or, alternatively, positioning an electrode either immediately in front of the bushing within the tank or immediately after it and in contact with the flow stream.

At the other end of the flow stream, electrical connection to the spinning device 7 is made by means of a slip ring attached to the shaft of the spinning device and including static brushes 21 through which the electrical connection is made. Control of the current is by way of a transformer (not shown) with suitable voltage and current output. Current variation may be achieved by, for instance, thyristor control and an infrared receptor as described above.

In addition to the above described means for heating the glass stream, the apparatus may be provided with means for controlling the mass flow. These means are provided at the conduit 3 and involve cooling the glass stream emerging from the tank 1. The conduit is provided with an oversized aperture and is externally clad with a cooling jacket 23 through which may be fed cooling fluid. The jacket may be a simple coil wrapped round the bushing and fed with water or it may be an external annular ring through which compressed air is passed. As the molten glass passes through the bushing, the bushing is cooled and a layer of molten material is solidified within the bushing orifice. This has the effect of reducing the aperture size and thereby reducing the mass flow. Although there is a loss of heat from the flow stream, this is relatively small because the melt steam material is a poor thermal conductor when solidified.

The change in temperature is linear with mass flow and the flow rate can therefore be controlled by monitoring the outflow temperature with an infrared receptor directed at the flow stream immediately below the bushing. This receptor (not shown) is

connected to suitable electronic circuitry to vary the amount of coolant causing solidification within the bushing. Any heat losses arising from this control method are compensated for by the temperature control methods described above.

This method of mass flow control also has the benefit of allowing construction materials to be used with lower melting points than the temperature of the material it is controlling. This is possible because the molten material is flowing through a solidified layer of the same material and is not in direct contact with the bushing itself. The bushing may be at a temperature several hundred degrees lower due to the insulating effect of the solidified layer.

The above described methods allow fine control of flow streams being fed into the spinning devices such that fibres and flake may be produced with thicknesses below 250 nanometers and with thickness variations as low as 10 per cent.

Reference has been made above to the use of apparatus of the present invention for producing glass flakes and fibres. However it should be appreciated that the apparatus may be used for producing flakes or fibres of any other appropriate material including ceramic materials.

P016363.1 – 28-11-04

CLAIMS

1. Apparatus for forming fibres or flakes of material comprising means (1) for producing a heated stream of molten material (9), means (3) for feeding the stream in a substantially vertically downward direction, means (7) for receiving the downwardly directed stream and for forming fibres or flakes therefrom, and means (11,13,15,17) for effecting a change in the temperature of the stream subsequent to the production thereof whereby fibres or flakes of a desired thickness are obtained, characterised in that said temperature changing means are means for directly heating the stream by application thereto of microwave radiation or electric current while the stream is travelling in a vertically downward direction.

2. Apparatus according to Claim 1, wherein the apparatus is additionally provided with means for cooling the stream prior to it being fed in a downward direction.

3. Apparatus according to Claim 2, wherein the cooling means includes a conduit (3) through which the stream is fed, said conduit being surrounded by a cooling coil or jacket (23) through which an appropriate fluid may be fed.

4. Apparatus according to any of the preceding claims, wherein the apparatus is additionally provided with mass or volume flow control means.

5. A method for forming fibres or flakes of material comprising producing a heated stream of molten material, feeding the stream in a substantially vertically downward direction, receiving the downwardly directed stream and forming fibres or flakes therefrom, and effecting a change in the temperature of the stream subsequent to the production thereof whereby fibres or flakes of a desired thickness are obtained, characterised in that the change in the temperature of the stream is affected by directly heating the stream by application thereto of microwave radiation or electric current while the stream is travelling in a vertically downward direction.

6. A method according to Claim 5, wherein, in addition to effecting a change in the temperature of the stream, a change is effected in the mass or volume flow of the stream.